LA-UR- 02-1470

Approved for public release; distribution is unlimited.

c.1

Title: Polymeric Materials Replacement Issues for the LANL Stockpile

Author(s): Cynthia W. Sandoval, Gary M. Gladysz, Thomas S. Stephens, Seth S. Gleiman, Daniel Mendoza, G. Keith Baker, Jon R. Schoonover, LANL, ESA-WMM

Jim Schneider, George McEachen, Brian Perry, Jim Lula, KCP

Submitted to: 24th Compatibility Aging Stockpile Stewardship Conference held at BWXT Pantex, Amarillo, TX, April 30 - May 2, 2002

Los Alamos
NATIONAL LABORATORY

24th Compatibility Aging Stockpile Stewardship Conference
BWXT Pantex
April 30 – May 2, 2002

"Polymeric Materials Replacement Issues for the LANL Stockpile"

Cynthia Sandoval, Gary Gladysz, Tom Stephens, Seth Gleiman, Daniel Mendoza, G. Keith Baker, Jon Schoonover – LANL

Jim Schneider, George McEachen, Brian Perry, Jim Lula - KCP

Engineering Sciences and Applications
Weapon Materials and Manufacturing

Los Alamos National Laboratory

Introduction:

A number of materials in the LANL stockpile are no longer available due to lack of availability or environment, safety and health issues. Silastic S-5370 a polysiloxane foam used to manufacture multiple components in LANL systems has been discontinued by Dow Corning. Kerimid 601 is a polyimide resin used as the binder for the syntactic foam used as a support material in the W76. It contains MDA, which has been identified by OSHA as a carcinogen and is no longer used in the nuclear weapons complex. In addition, the Thornel carbon mat used in the syntactic foam formulation is no longer available. These issues have created major challenges in the effort to reestablish aft support production capability for the W76 LEP. Urethane Encapsulant 7200, an adhesive used to bond explosive booster pellets and detonator components, was originally manufactured by Hexcel Corporation and is no longer available. The details of the projects currently underway to provide replacements for these materials will be discussed.

Silastic S-5370 Replacement:

Dow Corning Silastic S-5370 hydrogen blown silicone foam is an important material in Los Alamos National Laboratory systems. Unfortunately, Dow Corning removed this material from the market in late 1995.

A two-component mixture response surface experiment was designed and conducted to optimize the formulation of a replacement foam resin. The goal was to optimize the ratio of high molecular weight silanol to low molecular weight silanol in the formulation as an extension of work previously done by Dr. G. Keith Baker. A compounding methodology was developed and the starting materials and formulated resins were characterized for viscosity. The resins were evaluated for application time and free-rise density. Response studies for the fabricated foams included percent compression set and load at 20, 30 and 40 percent deflection. In addition, the foamed materials were examined by SEM and the role of the filler was explored. It was concluded that the filler serves primarily to allow good cell structure formation and improve stress-strain properties. An optimum foam formulation has been determined from the initial experiments.

The effort is currently in the second phase of a designed experiment to further optimize the replacement foam formulation while characterizing other responses. One property of particular interest is stress relaxation. Extractables will also be identified and quantified and a minimum sought. The effect of acid hydrolysis product in the catalyst and the effect of catalyst concentration in the foam product will also be studied. The selected formulation will be compounded at Honeywell, FM&T for use in the NWC. This approach will allow intimate knowledge of the silicone composition and compounding

process as well as improved quality control. Background on the project to date will be discussed along with results of the designed experiment.

Replacement Issues for W76 Aft Support Manufacture:

Table 1 is a comparison of data collected from past reports and recently tested syntactic foam material. Columns 1 and 2 are taken from a report written by H. McIlroy (High Temperature Syntactic Foam BDX-613-1534) in 1977 during the original development of the material. Columns 3 and 4 are more recent data which, when first discovered caused the Aft Support Sub-PRT to concentrate efforts on increasing flexural properties. Column 5 is a list of mechanical properties averaged from three stockpile return outer supports tested in September of 2001. Columns 6 and 7 are 5"x5" test billets with as received and thermally activated (TA) carbon microballoons (CMB), respectively. The last column presents data from specimens taken from a recent inner support billet. It represents the culmination of developmental improvements in the current project. Improvements include a new molding technique and processing cycle, new carbonization cycle for the microballoons, thermally activated absorption of oxygen into the surface of the CMB (TA), APO-BMI replacement resin, and removal of the Thornel Mat. The TA process was the mitigation step used to increase flexural properties of the syntactic foam. The 40/60 designation identifies material with only CMB and resin while 40/60/5 indicates material with 5% (wt) Thornel Mat. Columns 1, 2, and 5 are material with Kerimid 601 as the binder phase while the remaining have APO-BMI replacement binder.

Table 1. Comparison of Mechanical Properties of Carbon Syntactic Foam Material

Measurement	McIlroy 40/60	McIlroy 40/60/5	McEachen 1996	McEachen 2001 (40/60/5) (support billet)	Stockpile Return 40/60/5 (outer support)	Gladysz (40/60) As Received CMB (5x5 billet)	Gladysz (40/60) TA CMB (5x5 billet)	M
Flexural Strength, MPa	3.2	4.6	1.48	0.21	2.9 ± 0.2	4.13 ± 0.19	4.88 ± 0.17	3.
Flexural Modulus, MPa	571	587			552 ± 48	897 ± 17	878 ± 21	
Failure Strain (Flexural), %	0.94	1.46			0.53 ± .04	0.46 ± 0.02	0.56 ± .02	
Compressive Strength, MPa	7.93	7.51			5.93±0.36	7.52 ± 0.35	7.51 ± 0.40	9.
Compressive Modulus, MPa	480	670			553 ± 22	735 ± 62	648 ± 44	

The information above shows that comparable flexural properties can be obtained without the use of Thornel Mat. In addition, this increase is realized without sacrificing the compressive properties caused by the breaking of CMB during the intensive mixing. Intensive mixing is needed to disperse the Thornel Mat into the CMB/resin mix. The

background, current status, and future development required to supply aft supports for the W76 LEP will be discussed.

Urethane Encapsulant 7200 Adhesive Replacement:

Urethane 7200 adhesive was a Hexcel Corportation product removed from the market in the late1980's. The product was specified by LANL to be used for War Reserve assembly operations at the Pantex Plant (PX). The removal of the Urethane 7200 adhesive created a need for a replacement product, which has been under intermittent development for several years at Los Alamos National Laboratory. The replacement formulation is intended to replicate the composition of Urethane 7200 using commercially available starting materials.

The original Part A 7200 adhesive was analyzed using NMR spectroscopy by Joe Oswald of the Y-12 Plant back in 1995. The results determined Part A was composed of a 250 molecular weight polypropylene glycol (PPG), 650 molecular weight polytetramethylene glycol (PTMG) reacted with an excess of diphenylmethane 4,4'-diisocyanate (MDI) in a 5/22/73 weight percent respectively. The Urethane 7200 Part B was determined to be a polyether polyol with a hydroxyl number of 165 OH eq. wt.

Suitable replacements for both Part A and B have been identified (see Table 1). Part A is an isocyanate prepolymer mainly consisting of Dow Isonate 143L modified MDI with various amounts of the PPG and PTMG. Part B was found to be qualitatively similar to a commercial branched polyether triol, Baycoll NT1380, manufactured by Bayer.

The baseline formulation is similar to that of Urethane 7200, which is nominally 0.845 NCO-to-OH ratio with the Part A equivalent weight at 240. Various formulations of Part A are currently being developed in order to down-select to a composition that is a suitable replacement. At the same time, the ratio of the isocyanate prepolymer (part A) to polyether triol (part B) will be optimized by evaluating samples over a range of isocyanate-to-hydroxyl ratio. Characterization of the 7200 replacement includes; Shore D hardness, bond strength, viscosity, heat of reactions, compatibility/aging analysis with HE and other polymers, and various chemical analytical techniques.

Table1. Identified starting materials for Urethane 7200 Replacement

Part A
Dow Isonate 143L modified MDI
Dow Polyglycol PT250
BASF Pluracol P425
BASF PolyTHF 650
Part B
Bayer Baycoll NT1380

Summary:

Since the opportunity for nuclear testing no longer exists, care is taken to ensure that replacement materials are developed to not interfere with weapon certification. Small

scale core stack compatibility tests (JTA-18A) for the W76-1 are planned and will be the first to incorporate the replacement materials for Silastic S-5370, Kerimid 601 and Urethane 7200.